Developing Cryogenic Heat Exchangers for Selective Cabin Air Separation

Completed Technology Project (2017 - 2018)

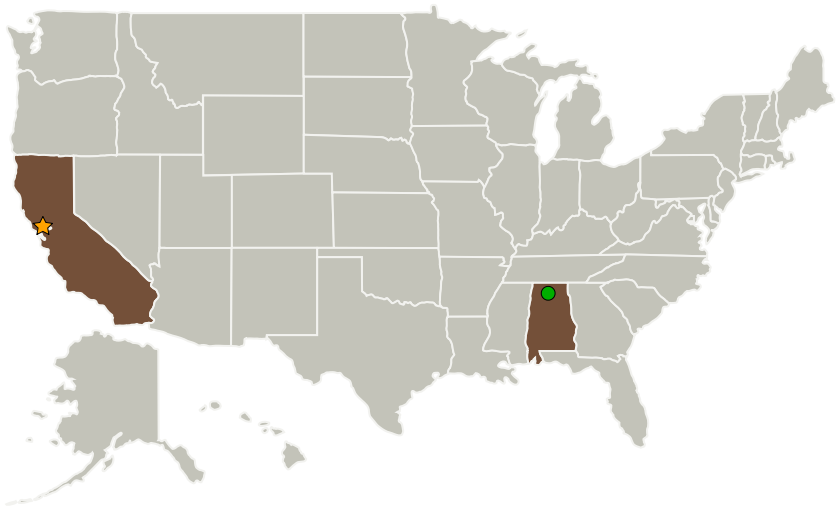
Project Introduction

Two HExs will be designed that will interface with in-house Stirling cryo coolers: the residual H2O/VOC cold trap, and the CO2 deposition chamber. We'll calculate surface area requirements for the subscale system using flow rates and cooling power, generate multiple CAD designs, and thermally model select ones to confirm performance of the design. Successful designs will be 3D printed in Cu and installed in the subscale cryo CO2 removal system. Performance and power savings will be compared to determine the most efficient prototypes. Next steps include incorporation of deep space passive thermal radiators to further reduce power. Proposal of full-scale CO2 removal ground system testing and eventually flight test system, as well as submission of technical papers, patent applications, and collaboration with industry partners that perform selective air separation processes.

Anticipated Benefits

Any group invested in CO2 collection may benefit from this technology, including spacecraft cabin scrubbing on future missions (e.g. Gateway), Mars ISRU, EPA and sequestration efforts, industry gas separation, etc. Methods employing cryocoolers to collect CO2 are already being developed by some of these groups.

Primary U.S. Work Locations and Key Partners



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Center Innovation Fund: ARC CIF

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Organizations Performing Work	Role	Type	Location
Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	California

Project Transitions

October 2017: Project Start

September 2018: Closed out

Closeout Summary: In order to utilize the difference in condensation and deposition temperatures of air components as a reliable method to separate CO2 from spacecraft cabin atmosphere, the cooling power required must be optimized. Therefore, the cold surface extension, or finhead, to be attached to a cryocooler and capture the CO2 was modeled to predict both thermal and mass transfer performance. The finhead was designed with a complex geometry to increase surface area and promote turbulent airflow, then fabricated via selective laser melting. The finhead was installed in the subscale CO2 Deposition system and its performance was tested. The initial finhead design did not perform as well as expected due to having too low of a surface area to mass ratio, but the effect of the design on the performance is now understood and will be implemented on future iterations until the CO2 capture is optimized. The current TRL level is 4, but the CO2 Deposition system will continue to be developed.

Project Website:

https://www.nasa.gov/directorates/spacetech/innovation_fund/index.html#.VC

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

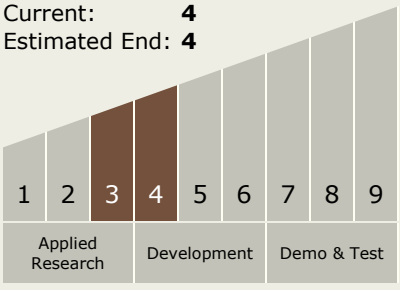
Harry Partridge

Principal Investigator:

Grace A Belancik

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.1 Environmental Control & Life Support Systems (ECLSS) and Habitation Systems
    - TX06.1.1 Atmosphere Revitalization

Target Destinations

Earth, The Moon, Mars